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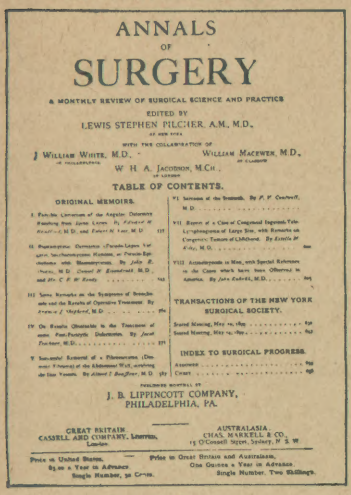

ANNALS
OF
SURGERY

A MONTHLY REVIEW OF SURGICAL SCIENCE AND PRACTICE

EDITED BY
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SEPTEMBER, 1901

Studies of the Blood in its Relation to Surgical Diagnosis.

BY RICHARD C. CABOT, M.D., JOHN B. BLAKE, M.D., AND J. C. HUBBARD, M.D.,

OF BOSTON, MASS.

STUDIES OF THE BLOOD IN ITS RELATION TO SURGICAL DIAGNOSIS.[1]

By RICHARD C. CABOT, M.D., JOHN B. BLAKE, M.D., AND J. C. HUBBARD, M.D.,

OF BOSTON, MASS.

Among the problems which we undertook to investigate during the preparation of this paper, sufficient material for valid inferences has been secured only in four, viz.:

(1) The effects of ether upon the leucocyte count.

(2) The effects of operation upon the leucocyte count.

(3) The effects of fractures upon the leucocyte count.

(4) The regeneration of the blood after operations for malignant disease.

We shall also present, however, some observations which seem to us of interest on the variations of the white count in typhoid fever, and after muscular exertion.

I. *Leucocytosis after Ether.*—The importance of determining whether leucocytosis is increased by ether narcosis is obvious in the postoperative treatment of surgical cases. During this period the temperature chart and the leucocyte count are sometimes consulted for information regarding the progress of the healing process, and the possibility of septicæmia or of deep-seated pockets of pus. It is obvious that if we are to draw any conclusions from the leucocyte count, we must know, first, whether ether *per se* has any tendency to produce leucocytosis, and, secondly, how much, if at all, the leucocytes are affected by the operation itself aside from its later results. To determine these facts, we have had the leucocytes counted

[1] Read before the American Surgical Association, May, 1901.

(*a*) Before the ether was administered.

(*b*) After full anæsthesia and before the beginning of the operation.

(*c*) After operation.

In this way we have investigated fifty cases. In a general way our results tend to show that there is little, if any, leucocytosis during the period just after full etherization and just before the beginning of the operation, while after the operation there is not infrequently a moderate increase of the white cells. Out of the total of fifty cases, only thirteen showed an increase of more than 2000 leucocytes after full anæsthesia, while in seven there was an actual diminution in the leucocyte count. The only cases in which there was a considerable increase after etherization are the following:

No. 1.—*Operation,* Hernia. *Before ether,* 9,400. *After ether,* 12,400.
No. 2.—*Operation,* Hernia. *Before ether,* 8,200. *After ether,* 13,600.
No. 3.—*Operation,* Hernia. *Before ether,* 6,800. *After ether,* 9,400.
No. 4.—*Operation,* Stone in the bladder. *Before ether,* 15,800. *After ether,* 19,920.
No. 5.—*Operation,* Cancer of the cervix. *Before ether,* 12,400. *After ether,* 17,000.
No. 6.—*Operation,* Ovariotomy. *Before ether,* 13,800. *After ether,* 21,000.
No. 7.—*Operation,* Vaginal section. *Before ether,* 14,600. *After ether,* 25,000.

These results are in sharp contrast with those of Chadbourne (*Philadelphia Medical Journal,* February 18, 1899), who studied twenty-one cases, and found an increase in *every* case, the average being 37 per cent. He noted, however, that the leucocytosis was most marked during the *first part of etherization,* and that the increase was exceedingly rapid, some cases showing a change of 70 per cent. within a few minutes. Very possibly the subsequent fall towards the completion of the anæsthesia may have been equally rapid. The differential counts in Chadbourne's cases showed that all varieties of leucocytes were increased, the lymphocytes somewhat more than the others. Chadbourne considers the leucocytosis to be due to the irritation produced by the ether vapor upon the respira-

tory tract. Exhibited in tabular form, our results are as follows:

TABLE I.

TABLE OF CASES OF LEUCOCYTE COUNTS BEFORE AND AFTER ANÆSTHESIA (ETHER) AND AFTER OPERATION.

CASE 1.—*Operation,* Litholapaxy. *Count before ether,* 15,800. *Count after ether but before operation,* 19,920. *Counts after operation,* 19,300 same day; 15,400 next morning.

CASE 2.—*Operation* (?). *Count before ether,* 6,000. *Count after ether but before operation,* 8,600. *Counts after operation,* 16,600 same day; 11,120 next morning.

CASE 3.—*Operation,* Senile gangrene. *Count before ether,* 17,200. *Count after ether but before operation,* 13,600. *Counts after operation,* 19,900 same day; 16,100 next morning.

CASE 4.—*Operation,* Cancer of cervix. *Count before ether,* 12,400. *Count after ether but before operation,* 17,060. *Counts after operation,* 20,700 same day; 10,400 next morning.

CASE 5.—*Operation,* Appendix. *Count before ether,* 18,100. *Count after ether but before operation.* 17,520. *Counts after operation,* 21,600 same day; 12,600 next morning.

CASE 6.—*Operation,* Stone in kidney. *Count before ether,* 7,900. *Count after ether but before operation,* 7,200. *Counts after operation,* 27,300 same day; 13,700 (T. 101+) next morning.

CASE 7.—*Operation,* Excision of elbow. *Count before ether,* 8,060. *Count after ether but before operation,* 9,100. *Count after operation,* 8,100 same day.

CASE 8.—*Operation,* Ether examination. *Count before ether,* 14,400. *Count after ether but before operation,* 10,200. *Count after operation,* 10,600 same day.

CASE 9.—*Operation,* Hernia. *Count before ether,* 3,660. *Count after ether but before operation,* 5,600. *Count after operation,* 10,900 same day.

CASE 10.—*Operation,* Exploratory laparotomy. *Count before ether,* 17,000. *Count after ether but before operation,* 17,400. *Count after operation,* 14,400 same day.

CASE 11.—*Operation,* Stricture of urethra. *Count before ether,* 6,000. *Count after ether but before operation,* 6,400.

CASE 12.—*Operation,* Hernia. *Count before ether,* 5,200. *Count after ether but before operation,* 5,400. *Count after operation,* 7,200.

CASE 13.—*Operation,* Gr. 1/6 strychnine given, gastro-enterostomy (cancer). *Count before ether,* 7,800. *Count after ether but before operation,* 7,600. *Count after operation,* 9,400.

CASE 14.—*Operation,* Cholecystotomy. *Count before ether,* 8,000. *Count after ether but before operation,* 9,200. *Count after operation,* 8,600.

CASE 15.—*Operation,* Gastrostomy. *Count before ether,* 6,400. *Count after ether but before operation,* 8,000. *Count after operation,* 8,400.

CASE 16.—*Operation,* Stricture of urethra. *Count before ether,* By

hospital officer, 10,000. *Count after ether but before operation,* 16,400. *Count after operation,* 16,000.

CASE 17.—*Operation,* Appendicitis. *Count before ether,* 8,600. *Count after ether but before operation,* 10,800. *Count after operation,* 10,200.

CASE 18.—*Operation,* Hernia (two and one-half hours). *Count before ether,* 9,000. *Count after ether but before operation,* 12,800. *Count after operation,* 13,400.

CASE 19.—*Operation,* Inguinal hernia. *Count before ether,* 6,000. *Count after ether but before operation,* 7,200. *Count after operation,* 8,400.

CASE 20.—*Operation,* Appendicitis. *Count before ether,* 16,000. *Count after ether but before operation,* 15,800. *Count after operation,* 17,200.

CASE 21.—*Operation,* Inguinal hernia. *Count before ether,* 8,200. *Count after ether but before operation,* 13,600. *Count after operation,* 14,800.

CASE 22.—*Operation,* Abscess of rectum. *Count before ether,* 10,000. *Count after ether but before operation,* 11,000. *Count after operation,* 11,000.

CASE 23.—*Operation,* Litholapaxy. *Count before operation,* 7,600. *Count after ether but before operation,* 8,800.

CASE 24.—*Operation,* Chronic mastitis. *Count before ether,* 14,800. *Count after ether but before operation,* 16,000. *Count after operation,* 16,600.

CASE 25.—*Operation,* Tumor of neck. *Count before ether,* 3,800. *Count after ether but before operation,* 4,600. *Count after operation,* 4,400.

CASE 26.—*Operation,* Hernia. *Count before ether,* 9,400. *Count after ether but before operation,* 12,400. *Count after operation,* 11,800.

CASE 27.—*Operation,* Empyema. *Count before ether,* 2,800. *Count after operation,* 23,000.

CASE 28.—*Operation,* Nephrectomy. *Count before ether,* 15,400. *Count after ether but before operation,* 15,800. *Count after operation,* 21,200.

CASE 29.—*Operation,* Enchondromata. *Count before ether,* 10,600. *Count after ether but before operation,* 11,000. *Count after operation,* 14,000.

CASE 30.—*Operation,* Hernia. *Count before ether,* 6,800. *Count after ether but before operation,* 9,400.

CASE 31.—*Operation,* Amputation of leg. *Count before ether,* 10,000. *Count after ether but before operation,* 12,800. *Count after operation,* 8,600.

CASE 32.—*Operation,* Suprapubic cystotomy. *Count before ether,* 20,400. *Count after ether but before operation,* 22,200. *Count after operation,* 22,800.

CASE 33.—*Operation,* Necrosis of tibia. *Count before ether,* 8,800. *Count after ether but before operation,* 11,200. *Count after operation,* 11,800.

CASE 34.—*Operation,* Salpingitis. *Count before ether,* 9,200. *Count after ether but before operation,* 9,800. *Count after operation,* 13,000.

CASE 35.—*Operation,* Laparotomy and vaginal section. *Count before ether,* 7,900. *Count after ether but before operation,* 11,800. *Count after operation,* 9,400.

CASE 36.—*Operation,* Vaginal section. *Count before ether,* 18,600. *Count after ether but before operation,* 22,200. *Count after operation,* 20,000.

CASE 37.—*Operation,* Vaginal section. *Count before ether,* 14,600. *Count after ether but before operation,* 25,000. *Count after operation,* 21,600.

CASE 38.—*Operation,* Vaginal section. *Count before ether,* 8,000. *Count after ether but before operation,* 11,200. *Count after operation,* 8,600.

CASE 39.—*Operation,* Laparotomy, double pus-tubes. *Count before ether,* 13,000. *Count after ether but before operation,* 15,000. *Count after operation,* 18,000.

CASE 40.—*Operation,* Hysterectomy (vaginal), considerable bleeding. Cancer of cervix. *Count before ether,* 8,900. *Count after ether but before operation,* 10,000. *Count after operation,* 19,800.

CASE 41.—*Operation,* Ovariotomy and ventral fixation. *Count before ether,* 13,800. *Count after ether but before operation,* 21,000. *Counts after operation,* 21,400 same day; 12,000 next day.

CASE 42.—Healthy medical student. *Count before ether,* 10,200. *Count after ether but before operation,* 11,000. *Count after ether,* 9,400.

CASE 43.—*Operation,* Ischiorectal abscess. *Count before ether,* 8,200. *Count after operation,* 10,000.

CASE 44.—*Operation,* Dilating and curetting; hæmorrhoids. *Count before ether,* 12,500. *Count after operation,* 22,000.

CASE 45.—*Operation,* Abscess on hand, opened. *Count before ether,* 14,000. *Count after operation,* 20,200.

CASE 46.—*Operation,* Suspension of uterus. *Count before ether,* 8,800. *Count after operation,* 24,000.

CASE 47.—*Operation,* Cervix and sphincter ani. *Count before ether,* 8,500. *Count after ether but before operation,* 9,200. *Count after operation,* 20,800.

CASE 48.—*Operation,* Vagina and hæmorrhoids. *Count before ether,* 7,500. *Count after ether but before operation,* 8,400. *Count after operation,* 14,500.

CASE 49.—*Operation,* Cervix uteri. *Count before ether,* 7,800. *Count after ether but before operation,* 10,400. *Count after operation,* 21,400.

CASE 50.—*Operation,* Vaginal operation. *Count before ether,* 7,200. *Count after ether but before operation,* 8,000. *Count after operation,* 19,000.

CASE 51.—*Operation,* Laparotomy. *Count before ether,* 8,200. *Count after operation,* 25,000.

CASE 52.—*Operation,* Breast. *Count before ether,* 6,500. *Count after operation,* 21,600.

CASE 53.—*Operation,* Vaginal. *Count before ether,* 8,000. *Count after operation,* 24,000.

CASE 54.—*Operation,* Amputation of cervix. *Count before ether,* 7,000. *Count after ether but before operation,* 8,800. *Count after operation,* 11,500.

CASE 55.—*Operation,* Dilating and curetting. *Count before ether,* 6,800. *Count after ether but before operation,* 8,200. *Count after operation,* 19,400.

CASE 56.—*Operation,* Tumor in nose removed. *Count before ether,* 8,800. *Count after ether but before operation,* 8,000. *Count after operation,* 8,400.

CASE 57.—Healthy medical student. *Count before ether,* 8,200. *Count after ether but before operation,* 9,600. *Count after ether,* 7,800.

II. *Postoperative Leucocytosis.*—After operation, the leucocyte count was increased 2000 or more in thirty-five out of forty-seven cases, and 3000 or more in twenty-seven cases. This increase was in twenty-four cases, or one-half of all, a relatively slight one, amounting on the average to not more than 20 per cent., and in five cases there was an actual decrease. In a few cases leucocytosis was considerable; for example, (*a*) case of stone in the kidney: before operation, but after complete etherization, 7200; four hours later, after operation, 27,300; next morning, 13,700. Temperature, 101° F. (*b*) Nephrectomy. Before operation, but after ether, 15,400; after operation, 21,200. As a result of our counts in forty-seven cases, we conclude that operation has by itself a considerable tendency to increase the leucocyte count in about one-half the cases, while in the remaining half no leucocytosis of importance occurs. Regarding the duration of the postoperative leucocytosis which occurred in our cases, we have accurate notes in only ten cases. In these it appears that within thirty-six hours from the time of the operation the postoperative leucocytosis has generally disappeared. In seven of our ten cases the count on the day following the operation was lower than on the morning of the operation.

III. *Fractures.*—Experiments have shown that a leucocytosis can be produced in animals by a simple fracture. To investigate the possibility of a similar leucocytosis following fractures in human beings, we have made thirty-two counts in twenty-three cases of simple fractures, including five of the

leg, three of the fibula, two of the ribs, three of the radius, one of the patella, one of the pelvis, one of the spine, one of the astragalus, etc. In these cases there are ten showing a leucocyte count of more than 10,500, but in only six did the count reach above 12,000. The highest counts were 15,400 in fracture of the pelvis, 14,800 in fracture of the leg. As a result of these counts, it would seem that simple uncomplicated fractures seldom increase the leucocyte count to any considerable extent. In one case of fracture of both bones of the leg in which fat embolism was suggested by lung symptoms and signs, the leucocyte count rose to 15,600, falling next day to 10,600. In one case of fracture of the ribs with injury to the lung, the count made two days after the injury showed 14,900 white cells. A compound fracture of the leg counted two hours after the injury showed only 5400.

TABLE II.

TABLE OF CASES OF COUNTS OF THE LEUCOCYTES AFTER FRACTURES.

CASE 1.—*Bones broken* (?). *Counts,* 9,200 same day; 10,200 next day.

CASE 2.—*Bones broken,* Fractured nose. *Counts,* 15,600, same day; 10,100 next day. *Remarks,* Hæmorrhage.

CASE 3.—*Bones broken,* Colles' fracture. *Count,* 10,800. *Remarks,* Left hospital before second count.

CASE 4.—*Bones broken,* Compound fracture of tibia. *Counts,* 10,400 same day; 7,300 next day.

CASE 5.—*Bones broken,* Both bones of leg. *Counts,* 6,800 same day; 5,000 next day.

CASE 6.—*Counts,* 6,400 same day; 5,900 next day.

CASE 7.—*Counts,* 10,700 same day; 8,400 next day.

CASE 8.—*Bones broken,* Fracture of fibula. *Counts,* 11,600 same day; 8,800 next day.

CASE 9. —*Bones broken,* Both bones of leg. *Counts,* 11,300 same day; 8,200 next day. *Remarks,* Ether.

CASE 10.—*Bones broken,* Fracture of ribs. *Counts,* 7,900 same day; 8,100 next day.

CASE 11.—*Bones broken,* Fracture of clavicle, rib, and scapula. *Counts,* 9,900 same day; 8,600 two days later.

CASE 12.—*Bones broken,* Fracture of astragalus. *Count,* 10,800.

CASE 13.—*Bones broken,* Fracture of patella. *Count,* 8,800.

CASE 14.—*Bones broken,* Fracture of fibula. *Count,* 11,200.

CASE 15.—*Bones broken,* Fracture of patella, March 20. *Count,* 9,600, March 21, 9.05 A.M. *Remarks,* No ether.

CASE 16.—*Bones broken,* Fracture of scapula, February 19. *Count,* 12,500, February 20, 3.45 P.M. *Remarks,* No ether.

CASE 17.—*Bones broken,* Fracture of leg, February 21. *Count,* 13,100, February 22, 4.20 P.M. *Remarks,* No ether.

CASE 18.—*Bones broken,* Fracture of astragalus, March 15. *Count,* 11,400, March 16, 12.15 P.M. *Remarks,* No ether.

CASE 19.—*Bones broken,* Fracture of fibula, February 14. *Counts,* 8,600, February 15, 11.30 A.M. *Remarks,* No ether.

CASE 20.—*Bones broken,* Fracture of fibula, February 13. *Count,* 13,600, February 15, 12 M. *Remarks,* No ether.

CASE 21.—*Bones broken,* Fracture of pelvis, March 31. *Count,* 15,400, April 2, 11.30 A.M. *Remarks,* No ether.

CASE 22.—*Bones broken,* Fracture of spine, April 2. *Count,* 14,600, April 3, 11.45 A.M. *Remarks,* No ether.

CASE 23.—*Bones broken,* Fracture of leg, April 4. *Count,* 10,100, April 5, 11.45 A.M. *Remarks,* No ether.

CASE 24.—*Bones broken,* Fracture of leg, April 6. *Count,* 14,800, April 8, 11.45 P.M. *Remarks,* No ether.

CASE 25.—*Bones broken,* Fracture of clavicle, ribs, injury to lung, March 16. *Count,* 14,900, March 18. *Remarks,* No ether.

CASE 26.—*Bones broken,* Compound fracture of leg, March 22, 9.15 A.M. *Count,* 5,400, March 22, 11.30 A.M. *Remarks,* No ether.

CASE 27.—*Bones broken,* Fracture of thigh, March 25. *Count,* 14,260, March 26, 12.10 P.M. *Remarks,* Ether, March 25, P.M.

CASE 28.—*Bones broken,* Compound fracture of arm, fracture of scapula. *Count,* 13,000, March 5, 12.15 P.M. *Remarks,* Ether, March 4, P.M.

CASE 29.—*Bones broken,* Fracture of skull, scalp wound, February 16, P.M. *Count,* 12,100, February 17, 10.50 A.M. *Remarks,* No ether.

CASE 30.—(Baby.) *Bones broken,* Greenstick arm, put up February 11. *Count,* 15,200, February 12, 10.30 A.M. *Remarks,* Ether, February 11.

CASE 31.—*Bones broken,* Impacted hip, February 4. *Count,* 11,600, February 12. *Remarks,* Ether, February 4.

CASE 32.—*Bones broken,* Fracture of leg, February 4. *Count,* 6,600, February 12. *Remarks,* No ether.

CASE 33.—*Bones broken,* Impacted hip, four and one-half weeks ago. *Count,* 6,800.

CASE 34.—*Bones broken,* Fracture of both bones of leg, January 30. *Counts,* 15,600, February 2; 10,600, February 3. *Remarks,* Fat embolism (?).

CASE 35.—*Bones broken,* Pott's fracture, April 22 or 23. *Count,* 5,850, April 24, 11.20 A.M.

IV. *Blood Regeneration after Operations for Malignant Disease.*—Bierfreund (Langenbeck's *Archiv,* Vol. xli) makes the astonishing statement that after operations for malignant disease the hæmoglobin never reaches the point at which it

was before operation. To determine the correctness of this curious statement, we examined thirteen cases of cancer, and arrived at results wholly opposed to those of Bierfreund. Thus in a case of cancer of the breast, the hæmoglobin on February 23 was 70 per cent., and on March 18, after operation, the hæmoglobin was 85 per cent., and in five cases entering the hospital for a second time after a recurrence of a cancerous growth, the hæmoglobin averaged 87 per cent. In no one of them was it markedly diminished.

TABLE III.

TABLE OF CASES OF HÆMOGLOBIN REGENERATION AFTER OPERATIONS FOR MALIGNANT GROWTH.

CASE 1.—*Disease,* Mammary cancer. *Hæmoglobin before operation,* 70 per cent. *Hæmoglobin after operation,* 70 per cent. *Time elapsed,* Ten days.

CASE 2.—*Disease,* Mammary cancer. *Hæmoglobin before operation,* 90 per cent. *Hæmoglobin after operation,* 80 to 90 per cent. *Time elapsed,* Six days.

CASE 3.—*Disease,* Cancer of uterus. *Hæmoglobin before operation,* 80 per cent. *Hæmoglobin after operation.* 90 per cent. *Time elapsed,* Four days. This case simply curetting and cauterizing the growth.

CASE 4.—*Disease,* Cancer of cervix. *Hæmoglobin before operation,* 90 per cent. *Hæmoglobin after operation,* 80 per cent. *Time elapsed,* Ten days.

CASE 5.—*Disease,* Recurrent cancer in vagina after hysterectomy in August, 1900. *Hæmoglobin before operation,* 90 per cent. *Hæmoglobin after operation,* 90 per cent. *Time elapsed,* Six days.

CASE 6.—*Disease,* Cancer of left breast. Recurrence. *Hæmoglobin after operation,* 90 per cent. *Hæmoglobin after operation,* 90 per cent. *Time elapsed,* March, 1896, to October, 1899. Recurrent nodules. Removed May and November, 1900. *Time elapsed,* Six days.

CASE 7.—*Disease,* Recurrent cancer, second operation. *Hæmoglobin before operation,* 90 per cent. *Hæmoglobin after operation,* 90 per cent. minus. *Time elapsed,* Eight days. First operation February, 1900; second operation, November, 1900.

CASE 8.—*Disease,* Cancer of breast. *Hæmoglobin before operation,* 90 per cent. *Hæmoglobin after operation,* 90 per cent. *Time elapsed,* Second operation, May 21, 1899; time elapsed, eight days.

CASE 9.—*Disease,* Cancer of breast. *Hæmoglobin before operation,* 80 per cent. *Time elapsed,* Second operation, December 1, 1900; Count, April 8.

CASE 10.—*Disease,* Cancer of uterus. Dermoid ovary. *Hæmoglobin before operation,* 80 to 90 per cent. *Hæmoglobin after operation,* 90 per cent. *Time elapsed,* Eighteen days.

CASE 11.—*Disease,* Second operation for osteosarcoma of thigh. *Hæmoglobin before operation,* 100 per cent. *Hæmoglobin after operation,* 90 per cent. *Time elapsed,* Eight days.

CASE 12.—*Disease,* Malignant disease of stomach. Extensive cancer. Exploratory laparotomy. *Hæmoglobin before operation,* 50 per cent. *Hæmoglobin after operation,* 45 per cent. *Time elapsed,* Twenty-two days, general condition worse.

CASE 13.—*Disease,* Carcinoma of lips. *Hæmoglobin before operation,* 80 per cent. *Hæmoglobin after operation,* 80 per cent. *Time elapsed,* Eight days.

V. *Variations of the Counts in Cases of Typhoid Fever examined from Hour to Hour.*—In the writings of Cushing, Thayer, and others, considerable stress has been laid upon the occurrence of a short "wave" of leucocytosis as suggestive of perforation of the intestine. This wave of leucocytosis has been apparent in some cases only when hourly or half-hourly counts were made, and would have been altogether overlooked had counts been made only once or twice in twenty-four hours. It appears to us that such a wave of leucocytosis may, and probably does, occur in many conditions other than intestinal perforation, and even without any recognizable pathological lesions. Thus, in a convalescent typhoid were recorded the following counts:

4.15 P.M., Leucocytes, 10,100.
5.15 P.M., Leucocytes, 5,800.
6.05 P.M., Leucocytes, 9,060.

In a healthy subject, thirty-one years of age, the following counts were recorded:

5.15 P.M., Leucocytes, 5700.
5.30 P.M., Leucocytes, 6600.
5.50 P.M., Leucocytes, 7700.
6.05 P.M., Leucocytes, 8400. (So far is to be observed a steady increase.)
6.15 P.M., Leucocytes, 5400.

In view of these and similar variations observed in ten other cases (four of which were cases of typhoid fever), we believe it is unsafe to base any inferences regarding diagnosis and treatment upon such temporary "waves" of leucocytosis. That leucocytosis usually exists in typhoid perforation we

are well aware, but in order to be of diagnostic value such leucocytosis must be relatively steady and not of the type described by Cushing.

TABLE IV.

TABLE OF CASES OF FREQUENT LEUCOCYTE COUNTS IN TYPHOID FEVER AND IN HEALTH.

CASE 1.—*Diagnosis,* Typhoid, third week. *Hour and Count,* 11 A.M., 8,200; 12 M., 10,300; 1 P.M., 12,200; 2 P.M., 10,300; 3 P.M., 11,400; 4 P.M., 15,400; 5 P.M., 7,500; 6 P.M., 28,800; 7 P.M., 10,600. *Remarks,* Several hæmorrhages before, during, and after counts. No perforation. Recovery. Steady improvement after counts.

CASE 2.—*Diagnosis,* Typhoid. *Hour and count of whites,* Entrance, 6,300; eight days later, September 15, 9.20 A.M., 8,800; 10.25 A.M., 14,300; 12.20 P.M.,12,800; 1.20 P.M., 10,600; 2.20 P.M., 8,400; 5.20 P.M., 10,600; 8.10 P.M., 14,300; 10 P.M., 1,300. September 16, 8.15 A.M., 20,200; 10 A.M., 22,000; 11 P.M., 18,800. September 17, 9.45 A.M., 9,000. *Remarks,* Boy, fifteen years; twelve days' duration at entrance. At 6 A.M. sharp abdominal pain, no vomiting; one hour later, chill. 8.45 A.M., slight general distention. 1 P.M. subnormal, anxious expression, pain. Parents refused operation. September 17, 10.20 A.M., died. Symptoms of general peritonitis.

CASE 3.—*Diagnosis,* Typhoid. *Count,* 13,300. *Remarks,* Woman, eighteen years; sixth week. Sudden pain and swelling in leg; phlebitis.

CASE 4.—*Diagnosis,* Typhoid. *Count,* 4,200; 8.30 A.M., 8,600; 1.30 P.M., 5,500; 5 P.M., 3,200; 8 P.M., 5,000. *Remarks,* Boy, sixteen years. Admitted, September 14; one week's duration. Perforation, September 26, chill at 3.30 A.M. Transferred to surgical operator Lived four days. No general peritonitis at operation.

CASE 5.—*Diagnosis,* Typhoid. *Hourly count,* First, 6,400; second, 6,600; third, 6,000. *Remarks,* Five days before hæmorrhage and death.

CASE 6.—*Diagnosis,* Typhoid. *Hour and count,* 3.45 P.M., 11,000; 4.45 P.M., 9,060; 5.35 P.M., 9,300.

CASE 7.—*Diagnosis,* Typhoid relapse. *Hour and count,* 4 P.M., 15,000; 5 P.M., 14,400; 5.50 P.M., 11,400.

CASE 8.—*Diagnosis,* Convalescent typhoid. *Hour and count,* 4.15 P.M., 10,100; 5.15 P.M., 5,800; 6.05 P.M., 9,060.

CASE 9.—*Diagnosis,* Typhoid. *Hour and count,* 4.30 P.M., 7,100; 5.20 P.M., 7,400; 6.20 P.M., 5,600.

CASE 10.—*Diagnosis,* Typhoid. *Hour and count,* 9.35 A.M., 7,300; 10 A.M., 5,100; 10.25 A.M., 5,700; 11.25 A.M., 6,850.

CASE 11.—*Diagnosis,* Typhoid. *Hour and count,* 1 P.M., 6,600; 2 P.M., 6,600; 3 P.M., 6,800.

Diagnosis, Normal health. *Hour and count,* 4.30 P.M., 11,000; 4.45 P.M., 9,200; 5 P.M., 7,000; 5.15 P.M., 10,100.

Diagnosis, Normal health. *Hour and count,* 5.15 P.M., 5,700; 5.30 P.M., 6,600; 5.50 P.M., 7,700; 6.05 P.M., 8,400; 6.15 P.M., 5,400.

VI. *Leucocytosis after Severe Muscular Exertion.*— Finally, we think it may be of interest to put on record the following observations made upon four of the runners in a recent "Marathon race" of about twenty-four miles, which took place April 19, 1901. All the cases showed a very marked increase in the white cells. In one case the leucocytes rose from 3700 before the race to 20,800 after it. (See Table below.)

But still more interesting were the changes revealed by the differential count, which showed a very marked, absolute, and relative increase in the polymorphonuclear neutrophiles, with a corresponding diminution of the lymphocytes and an entire absence of the eosinophiles in three cases out of four, while in the fourth they were greatly reduced. In one case atypical forms of leucocytes, not to be observed in normal blood, were present.

The details of these counts are shown in the following table:

TABLE V.

DIFFERENTIAL WHITE COUNT BEFORE AND AFTER THE RACE.

Leucocytes before race.	Leucocytes after race.	Differential white count after the race.					
		Polymorphonuclear neutrophiles.	Large mononuclear and transit.	Small mononuclear.	Eosinophiles.	Myelocytes.	
Three days before, 9800; immediately before, 4800.	14,400		4	5.7	0	0	Reds normal. No eosinophiles found in two coverslip spreads. Hæmoglobin, 105 per cent.
Two days before, 5800.	16,200		4.7	4	0	0	Hæmoglobin, 98 per cent. Reds normal in size, some irregularity in staining. Among the forms classed as polymorphonuclear neutrophiles were an unusual number whose nuclei were but partly divided, and rarely one almost a myelocyte. No typical myelocytes.
		90.3					
		91.3					
Immediately before, 3700.	20,800	84.4	8	7.2	0.4	0	Hæmoglobin, 90 per cent. Reds normal.
Three days before, 8.30 P.M., 8200.	22,200	86	7.3	6.7	0	0	Hæmoglobin, 100 per cent. Some variability in coloring of reds. Reds otherwise normal.

To capitulate briefly:

(1) At the end of complete anæsthesia, there is occasionally a slight increase of leucocytes, but seldom a marked leucocytosis.

(2) At the end of operation, there is a considerable leucocytosis in one-half the cases, and in almost all cases some increase beyond that found at the end of complete anæsthesia.

(3) Simple uncomplicated fractures seldom increase the leucocyte count to any considerable extent.

(4) The blood after operation for malignant growths is not necessarily much impoverished, and regenerates, in favorable cases, quite normally.

(5) A variation in the hourly leucocyte count exists in

other conditions than the preperforative stage of typhoid, and may occur in health.

(6) Very violent physical exertion produces in the blood a condition which leaves physiological limits, and approaches or is identical with that found in disease.

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